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BOSTON SOCIETY OF CIVIL ENGINEERS

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PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, DECEMBER 19, 1917,

at 7.45 o'clock P.M., in the large LECTURE HALL, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASS.

Business of the Meeting. — To act on the amendment to By-Law 5, adopted at the November meeting and printed in the November number of the JOURNAL.

The subject of the papers and talks for the meeting will be, "Structural Features of the New Technology Buildings."

"Foundations," by Charles T. Main.

"Theoretical Design," by Sanford E. Thompson.

"Construction," by representatives of the Stone & Webster Engineering Corporation.

The lantern will be used.

The Committee on Social Activities will arrange for an inspection of the new buildings in the afternoon and for a supper at the Walker Memorial.

A special notice, giving further details, will be sent out later.

S. E. TINKHAM, *Secretary*.

PAPERS IN THIS NUMBER.

"Russia, — An Opportunity for American Engineers." George C. Whipple.

"Water Powers of New England." Henry I. Harriman.

Memoirs of Deceased Members.

CURRENT DISCUSSION.

Paper.	Author.	Published.	Discussion Closes.
"Lines and Grades in Tunnels of Small Diameter."	H. B. Pratt.	Nov.	Jan. 10.

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Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

BOSTON, November 21, 1917. — A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, and was called to order at 7.50 o'clock by the President, George C. Whipple.

There were 107 members and visitors present.

The record of the last meeting was read and approved.

The Secretary reported for the Board of Government that it had elected to membership in the grade of Member, Mr. Page Scribner Bunker; and in the grade of Junior, Messrs. Elmer Forest Allen, William Lohmeyer, Jr., and Edward Pierce Wells.

The Secretary presented and read the memoir of Past-President Joseph P. Davis, prepared by a committee consisting of Messrs. Frederic P. Stearns and Edward W. Howe. He also presented the memoir of Harold Parker, prepared by a committee consisting of Arthur W. Dean and William E. McClintock. Both memoirs were accepted and ordered printed in the JOURNAL.

The President announced the death of William S. Johnson, a member of the Society, which occurred on October 27, 1917, and by vote the President was requested to appoint a committee to prepare a memoir. Mr. X. Henry Goodnough has been appointed as this committee.

Mr. John E. Carty proposed an amendment to By-Law 5,

which had been printed with the notice of the meeting in the November, 1917, number of the JOURNAL, and moved its adoption in substitution for the present By-Law 5.

A discussion followed which was interrupted by the expiration of the time allowed for business under the By-Laws. At the close of the literary exercises, discussion of the proposed amendment was resumed. The following took part in the discussion: Messrs. J. E. Carty, F. B. Sanborn, S. H. Thorn-dike, R. E. Curtis, C. R. Gow, Frederick Brooks and H. P. Eddy. On a vote being taken, 58 members voted in favor of the adoption of the amendment and none against. The President stated that, under the By-Laws, the amendment would come up for final action at the next meeting.

For the literary exercises of the evening, the President, Prof. George C. Whipple, gave an extremely interesting informal talk about his journey to Russia as a member of the American Red Cross Mission.

At about ten o'clock the meeting adjourned.

S. E. TINKHAM, *Secretary*.

BOSTON, MASS., November 7, 1917. — The Sanitary Section of the Boston Society of Civil Engineers met in the Society rooms at 7.50 P.M., on Wednesday, November 7, 1917.

On motion of Professor Sanborn, Henry A. Varney was chosen Acting Clerk, to fill the unexpired term of Mr. Arthur D. Weston.

Major Glenn I. Jones, medical officer of the Base Hospital, Camp Devens, Ayer, Mass., discussed the course taken and the work done at the Camp during construction, to safeguard the health of the workmen.

Messrs. Barbour, Whipple and Allen also spoke on the same subject.

Thirty-seven members and visitors were present.

HENRY A. VARNEY, *Acting Clerk*.

APPLICATIONS FOR MEMBERSHIP.

[December 8, 1917.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

FOSTER, CLARANCE LESTER, Somerville, Mass. (Age 31, b. Pembroke, Mass.) Graduate of Cambridge Manual Training School; took special course in civil engineering at Boston Y. M. C. A., in mathematics at Tufts College, and in supervision at New York University. Draftsman with New England Structural Co. for period of four years, also for several summers; draftsman at G. W. & F. Smith's Iron Works and head draftsman with Builders' Iron and Steel Co. for a short time; has also worked for Berlin (Conn.) Construction Co. and was with Boston Elevated Railway Co. during one summer; taught drawing for several years in day and evening high school; during past year and a half has been representing Stone & Webster Engrg. Corp'n in territory east of Springfield, inspecting and expediting all classes of material, running tests, etc. Refers to E. W. Bailey, L. S. Cowles, C. M. Durgin, E. M. Moses, J. C. Moses, W. N. Patten and Daniel Scouler, Jr.

GILLET, LAURENCE ARNOLD, Newburyport, Mass. (Age 20, b. Newburyport, Mass.) Is fourth-year student at Mass. Inst. of Technology, sanitary engineering course. Refers to A. E. Burton, G. L. Hosmer, J. W. Howard, Dwight Porter, A. G. Robbins and G. C. Whipple.

JONES, PUSEY, Cambridge, Mass. (Age 37, b. Wilmington, Del.) Graduate of Delaware State College, 1902, civil engineering course. From June, 1902, to July, 1903, rodman with Pennsylvania R. R.; from July, 1903,

to June, 1905, assistant engineer in charge of topographic surveys with Du Pont Powder Co.; from 1905 to 1910, structural draftsman with New York, Westchester & Boston Ry.; from 1910 to April, 1912, assistant structural engineer with N. Y. W. & B. Ry.; from April, 1912, to January, 1913, principal assistant engineer on design and construction of trestles and bridges for Georgia Coast & Piedmont R. R., Brunswick, Ga., and from January, 1913, to May, 1914, chief engineer on same work; from July, 1914, to April, 1916, member of Atlantic Engineering Co., Savannah, Ga., work consisting chiefly of bridge and lock construction; from April, 1916, to June, 1917, chief structural draftsman in charge of design of all classes of railroad structures for B. & M. R. R.; from June, 1917, to date, acting engineer of structures, B. & M. R. R. Refers to A. B. Corthell, D. N. Peaslee, F. C. Shepherd and S. P. Waldron.

LIST OF MEMBERS.

ADDITIONS.

LEAVITT, ALBERT J.....23 Montvale St., Roslindale, Mass.
LOHMEYER, WILLIAM, JR.,
2d Lieut., Corps of Engrs., Barrack 47, McClellan Ave., Ft. Leavenworth, Kan.

CHANGES OF ADDRESS.

BOWERS, GEORGE W.....care A. Bensley Sons Co., Jacksonville, Fla.
BROWN, WILLIAM AUGUSTINE.....87 Homer St., East Boston, Mass.
CHASE, HORACE H.....206 Spring St., Brockton, Mass.
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JOHNSON, FRANK W.,
care American International Shipbuilding Corp., Hog Island, Pa.
KATZ, HARRY L.....48 Mt. Auburn St., Cambridge, Mass.
MOORE, CHESTER A.....6 Main St., Rockport, Mass.
SCOULER, DANIEL, JR., care Port Arthur Shipbuilding Co., Port Arthur, Ont.
SOKOLL, JACOB M.....327 West Delavan Ave., Buffalo, N. Y.
SPALDING, FREDERIC P.....602 City Hall Annex, Boston, Mass.
SPEAR, WALTER E.Major, Quartermaster Corps,
care Camp Quartermaster, Camp Upton, L. I., N. Y.
STROUT, HENRY E., JR.....Fort Leavenworth, Kan.
SUTHERLAND, REYNOLD H.....157 Ocean St., Lynn, Mass.
THOMAS, HOWARD C.....34 Floral St., Newton Highlands, Mass.
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WOOD, CARL W.....147 Mills St., Boston, Mass.
YOUNG, ERVING M.....care Supervising Engineer, Camp Meade, Md.

LIBRARY NOTES.

BOOK REVIEW.

BUSINESS LAW FOR ENGINEERS, by C. Frank Allen, M. Am. Soc. C. E., member Massachusetts Bar, M. Am. Railway Eng. Assoc. Part I, Elements of Law for Engineers; Part II, Contract Letting. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth, 6 x 9 in.; pp. 494. \$3.00.

Reviewed by Alfred D. Flinn.

Reviewing Professor Allen's book has been pleasurable as well as profitable, because of the clear, compact style and the logical sequence of arrangement. Never before has the reviewer read so lucid and instructive a summary of the fundamentals of American law and its practice. In Part I the selection of topics is amply broad, and the matter given under each topic sufficient to meet the needs of an engineer in the practice of his profession and in all ordinary business transactions. Frequently the author points out where it is wise and where necessary for an engineer to seek the professional services of a lawyer, and in other places indicates that engineering knowledge of the situation should dominate or guide the legal handling of the case. Throughout Part I the basic principles or theories of the law on the points under discussion are made plain, often by adverting to the historical origin of a practice or precept and tracing the development of the idea. Such presentation helps to make the reasonableness of the law appear even in some cases that have seemed arbitrary to the layman, and is helpful to intelligent control of professional and business conduct or the right choice of procedure when legal action must be taken.

Incidentally to summarizing the law, some wholesome suggestions as to engineering practice are dropped.

"Following the principle underlying the Common Law, that stability is a prime necessity, it would add much to the dignity and respect accorded to the profession of engineering, to the engineer and surveyor, if greater stability was secured from their work. A boundary line once reasonably fixed by one surveyor should be held to by another surveyor unless

definitely found to be in error. In other directions, unnecessary disagreements should be avoided, and, so far as reasonable, engineering should be recognized as fixed and definite in its principles. The entire profession of engineering suffers when the work of a reputable engineer is unnecessarily attacked or held up to contempt."

Another suggestion deals with the "Importance of Clear Expression. It would be quite improper to leave the question of the interpretation of writings without making the suggestion that the engineer who has to do either with the production or interpretation of writings can have no better preparation than a thorough training in the clear expression of English and a critical analysis of its meaning. The school training must be supplemented by systematic work in this direction." Engineers are the authors of many documents on which action is based and by which it is guided, often affecting the security of life or the safety of property of great value, demanding, therefore, statement so clear as to eliminate reasonable question of meaning.

Part II discusses in order the documents which commonly are comprised in the book or pamphlet of an engineering contract for large work: Information for Bidders, Proposal, Contract Form, Bond and Specifications. The last two are dealt with very briefly. Under Specifications the endeavor is made to indicate what is proper subject matter and what belongs in the agreement, or contract proper, or in the Information for Bidders, and to suggest proper forms and suitable methods of expression.

"Clearness of description is of the utmost importance. For this a clear vision of what is wanted is the first requisite. To this must be added sufficient ability in the use of language to make clear to others what the engineer sees clearly. An able contractor has stated that his training in descriptive geometry was of great value to him because it permitted him to visualize a piece of work."

Logical arrangement is shown to be of great importance. Some of the discussions under this heading, however, particularly that relating to borings and other preliminary examinations of the sites of works, might have been put more appropriately under Information for Bidders.

The "Uniform Contract Form" of the American Railway Engineering Association is used as the basis for the discussion of the agreement, or contract proper, and with the following chapter on "Additional Contract Forms" constitutes the greater portion of Part II. Numerous quotations are made from contract forms which have been used by various companies and municipalities. The value of these quotations would be enhanced if their identity were disclosed and the magnitude, character and location of the works at least very briefly outlined. This might be accomplished in another edition by suitable, suggestive abbreviations after each such quotation and a short chapter of condensed explanations.

Good typography and a binding similar to that standard for law books give the book an attractive appearance. It is noticeably free from errors of proofreading. The book should prove useful to many engineers and to men of other pursuits also.

RECENT ADDITIONS TO THE LIBRARY.

U. S. Government Reports

Deterioration in Heating Value of Coal during Storage. Horace C. Porter and F. K. Ovitz.

Emergency Fuel from Farm Woodland. A. F. Hawes.

Experimental Roads in Vicinity of Washington, D. C. B. A. Anderton and J. T. Pauls.

Method for Measuring Viscosity of Blast-Furnace Slag at High Temperatures. Alexander L. Feild.

Production of Explosives in United States during Calendar Year 1916. Albert H. Fay.

Red Spruce: Its Growth and Management. Louis S. Murphy.

Results of Magnetic Observations Made by United States Coast and Geodetic Survey in 1916. Daniel L. Hazard.

Safe Practice at Blast Furnaces. Frederick H. Willcox.

Underground Wastes in Oil and Gas Fields, and Methods of Prevention. William F. McMurray and James O. Lewis.

Use of Mud-Laden Fluid in Oil and Gas Wells. James O. Lewis and William F. McMurray.

Yearbook of Bureau of Mines, 1916. Van. H. Manning.

State Reports.

Massachusetts. Report on Improvement of Upper Mystic River and Alewife Brook by Means of Tide Gates and Large Drainage Channels. John R. Freeman. 1904.

Michigan. Report of State Board of Health on Water Chlorination, 1917.

Michigan. Report of State Board of Health on Water Filtration, 1917.

Ohio. Report of State Board of Health for Six Months ending June 30, 1915.

City and Town Reports.

Chicago, Ill. Report of Bureau of Public Efficiency on Primary Days and Election Days as Holidays.

Cleveland, Ohio. Report on Tests at Sewage Testing Station, 1914.

New York, N. Y. Building Code, Borough of Manhattan, 1917.

New York, N. Y. Report of Bureau of Buildings for 1915.

New York, N. Y. Contract, Specifications, etc., for Construction of Shandaken Tunnel, 1917.

Newton, Mass. Annual Report of Street Commissioner for 1916.

Miscellaneous.

American Institute of Mining Engineers: Transactions for 1916, Vol. LV.

Boston Elevated Railway Company: Satisfactory Service and Sound Securities. M. C. Brush.

Canada, Department of Mines: Mining of Thin-Coal Seams as Applied to Eastern Coal-Fields of Canada, by J. F. Kellock Brown; Test of Some Canadian Sandstones to Determine Their Suitability as Pulpstones, by L. Heber Cole.

Inspection of Screw Gauges for Munitions of War. H. J. Bingham Powell, Inspector in Charge, Department of Gauges and Standards, British Ministry of Munitions of War in United States. Gift of author.

Street Lighting Rates in City of Boston: Hearing before Massachusetts Board of Gas and Electric Light Commissioners: Brief in Behalf of City; Brief for Edison Electric Illuminating Company of Boston. Gift of H. S. Knowlton.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

Commonwealth of Massachusetts.—METROPOLITAN WATER AND SEWERAGE BOARD.—*Water Works.*—Work on high-tension transmission line between the Wachusett and Sudbury power stations is in progress. The poles are erected for a distance of about 12 miles out of the total of 15.5 miles, and the concrete foundations are in place for 9 out of the 14 steel towers.

The steam turbine has been delivered at the Arlington pumping station, and the concrete foundation is in place for the new centrifugal pumping unit at this station.

METROPOLITAN WATER AND SEWERAGE BOARD. — *Sewerage Works.* — Work in progress: Section 98 and Section 102, Wellesley Extension.

METROPOLITAN PARK COMMISSION. — *Old Colony Parkway.* — Construction of a temporary bridge across the Neponset River between Boston and Quincy is in progress; also construction of double siphon for water and gas under new channel.

BOSTON TRANSIT COMMISSION. — *Dorchester Tunnel.* — The interior finish of Broadway Station is about completed.

Work is progressing on the interior finish of the station at Andrew Sq., and work is in progress on the station for transfer of passengers from the surface cars to the tunnel below. This station is about 115 ft. in width and will have three platforms, and extends from Dorchester Ave. to Ellery St., a distance of about 300 ft.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

SOUTH BOSTON.

Ralston St.,	Dorchester Ave. to Old Colony Ave.	Bituminous macadam.
Alger St.,	Dorchester Ave. to Railroad.	Filling.

EAST BOSTON.

Neptune Rd.,	Bennington St. to Railroad.	Asphalt.
Gove St.,	Cottage St. to Venice St.	Topeka.
Maverick Sq.,	Summer St. to Maverick St.	Asphalt.

BRIGHTON.

Brighton Ave.,	Commonwealth Ave. to Cambridge St.	Asphalt.
Langley Rd.,	Breck Ave. easterly.	Bituminous macadam.
N. Beacon St.,	Cambridge St. to Market St.	Asphalt.
Breck Ave.,	Washington St. to Langley Rd.	Bituminous macadam.

WEST ROXBURY.

Ridge St.,	Brown Ave. to Sycamore St.	Artificial walks.
Brookside Ave.,	Boylston St. to Green St.	Artificial walks.
Sycamore St.,	Brown Ave. to Canterbury St.	Artificial walks.

DORCHESTER.

Dorchester Ave.,	Savin Hill Ave. to Freeport St.	Granite block.
Dorchester Ave.,	Peabody Sq. to Washington St.	Granite block.
Dorchester Ave.,	Freeport St. to Park St.	Granite block.
Norfolk St.,	Corbet St. to Blue Hill Ave.	Asphalt.
Richwood St.,	Centre St. to Montview St.	Asphalt.

ROXBURY.

Museum Rd.,	Huntington Ave. to Fenway.	Topeka.
Overland St.,	Brookline Ave. to B. & A. R. R. bridge.	Granite block.
Pontiac St.,	Tremont St. to Hillside St.	Bituminous macadam.
Beacon St.,	Raleigh St. to railroad bridge.	Asphalt.
Albany St.,	Concord St. to Northampton St.	Wood block.

CITY PROPER.

Hanover St.,	Court St. to Commercial St.	Artificial walks.
Atlantic Ave.,	Summer St. to beyond Congress St.	Artificial walks.
Harrison Ave.,	Dover St. to Kneeland St.	Granite block.
Tremont St.,	Eliot St. to Common St.	Sidewalks.

New York, New Haven & Hartford R. R. Co. — *South Boston Cut Improvement.* — Enlargement of South Boston Cut to Boston Freight Terminal, to accommodate four tracks instead of two, and reconstruction of eleven overhead highway bridges, so as to span four tracks instead of two, progressing.

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

**RUSSIA, — AN OPPORTUNITY FOR AMERICAN
ENGINEERS.**

By GEORGE C. WHIPPLE,* PRESIDENT, BOSTON SOCIETY OF CIVIL ENGINEERS.

HAVING been asked to tell the members of the Boston Society of Civil Engineers something about my work during the past summer as a member of the American Red Cross Mission to Russia, I gave an informal talk at the regular meeting of the Society held November 21, 1917. This related chiefly to facts and impressions which I gathered during the journey through Siberia to Petrograd and Moscow and my visit to the Russian army at the front.

The following notes give in substance what was said at that time.

THE CALL TO RUSSIA.

On the 19th of June, at eleven o'clock, as I was getting ready to go to bed at my home in Cambridge, I received a long-distance call from Mr. Henry P. Davison, chairman of the War Council of the American Red Cross Society, who told me that the President wanted me to go to Russia, and asked if I could be in New York to attend a conference at ten o'clock the next morning. I then and there decided that I would go. There was just time to dress and catch the sleeper.

In New York I met Dr. Frank Billings, who was to head

* Major and member of the American Red Cross Mission to Russia.

the Mission; Mr. Wm. B. Thompson, who had generously offered to finance the expedition as well as to accompany it; Prof. Henry S. Sherman, of Columbia; Prof. C.-E. A. Winslow, of Yale, and others. A few days later Mr. Davison came up from Washington, and everything was settled so far as I was concerned. Meantime Dr. Billings was securing other members and making the detailed arrangements for the journey. The date of departure was set for June 29 from Boston and New York, June 30 from Chicago. Within a week's time uniforms had to be made, passports and commissions secured, transportation arranged through to Russia, and medical and other supplies obtained from a score of firms scattered over many cities and concentrated so as to leave Vancouver on the *Empress of Asia*, on July 5. Besides this, the members of the Mission had to arrange their personal affairs and prepare for an absence of unknown duration. It seemed like an impossible task; but it was done. Every man was ready on time, and the supplies were on board. Too much credit cannot be given to the officials of the railroads, all the way from New York to Vancouver, who broke rules and cut red tape right and left, under the magic influence of the red cross symbol. Never before, perhaps, were cases of freight carried in the compartment cars of the Twentieth Century Limited. Never before, perhaps, was a Canadian Pacific limited train ordered to stop to pick up a freight car which had missed its connection.

THE FIRST MEETING.

The first meeting of the American Red Cross Mission to Russia was held in the Blue Room of the Hotel Vancouver, on the Fourth of July. There were twenty-nine in all, two lieutenant-colonels, twelve majors, six captains, six lieutenants and three orderlies. Beneath the American flags which decorated the room, these men pledged obedience to their commander, Colonel Billings, and their loyalty and their lives to the cause of the American Red Cross in Russia. After drinking a toast to the health of the President of the United States, Colonel Billings, holding up his glass of water, said, "I ask you all to pledge with me that until we return to America this shall be the

only beverage of the Red Cross Mission." The Mission then and there went on the water wagon, and perhaps no other single thing attracted so much notice or received such favorable comment in Japan, Russia and China as this abstinence from intoxicating liquors. The Japanese Red Cross Society who entertained the Mission at dinner at Tokyo had prepared an elaborate spread of glasses, and were much surprised to find that they would not be used. The matter was discussed at dinner, and the sentiment of the Japanese was that they too would adopt the custom at their Red Cross dinners, and when later on they entertained the American Red Cross Mission to Roumania they put the idea into practice. An amusing event happened at our Red Cross dinner. Not wishing the Japanese to feel offended at our failure to partake of their hospitality, Colonel Billings at the conclusion of his speech announced that the rule would be suspended in order that the health of the Japanese emperor might be appropriately drunk, but by that time most of the champagne glasses had been filled with tea, so the health of the emperor was drunk in the national beverage.

At this point mention should be made of the men who composed the Mission, for I want to bear witness that no better men, no more congenial companions, were ever gotten together. I regard it as an honor to have served with each and all of my colleagues.

First in order was Lieut.-Col. Frank Billings, of Chicago, physician, president of the American Medical Association, professor of medicine in the University of Chicago, and head of the great medical school about to be founded there, who had been twice to Russia and who was altogether the best equipped man in America for his important mission. Next was Lieut.-Col. Wm. B. Thompson, one of the big business men of the country, director of the United States Federal Reserve Bank of New York, well known not only for his successful business enterprises but for his benefactions to educational institutions.

The twelve majors represented the specialists of the Mission. The medical men were Dr. Wm. S. Thayer, professor of medicine in Johns Hopkins University, experienced in general medicine and in hospital work; Dr. D. S. McCarthy, fellow of the Phipps

Institute, Philadelphia, specialist in the study of tuberculosis, who has seen active service in Europe in the care of prisoners during the present war; Dr. Wilbur E. Post, assistant professor of medicine in the Rush Medical College of Chicago, experienced in the problems of industrial hygiene, who acted as "family physician" to the members of the Mission; Dr. Orrin S. Wightman, professor of clinical medicine, New York Polyclinic Hospital, who devoted his attention chiefly to photographic work, including moving pictures for the publicity work of the Mission; Dr. Malcolm Grow, Washington, D. C., major in the U. S. Medical Officers Reserve Corps, attaché, — familiar with certain problems through previous service in the Russian army.

The majors chosen for special service were Henry J. Horn, Boston, Mass., member of the corporation of the Massachusetts Institute of Technology, expert in railroad transportation; George C. Whipple, Cambridge, Mass., professor of sanitary engineering in Harvard University and the Massachusetts Institute of Technology, especially assigned to problems of military sanitation; Raymond Robins, Chicago, well known as a social economist and progressive political leader, expert in social relief work and intensely interested in the present political conditions in Russia; Dr. Henry C. Sherman, professor of food chemistry in Columbia University, New York, specialist in food problems; C.-E. A. Winslow, professor of public health in the Yale Medical School, specialist in public health administration and the problems of infant welfare; Harold H. Swift, executive head of Swift & Co., Union Stock Yards, Chicago, specialist in food supply; Thomas D. Thacher, lawyer, firm of Simpson, Thacher & Bartlett, New York, secretary of the Mission.

The captains were James W. Andrews, of St. Louis, accountant, the treasurer of the Mission; Allen Wardwell, lawyer, firm of Stetson, Jennings & Russell, New York, secretary to Colonel Billings, promoted to the rank of major while in Petrograd; Robert I. Barr, vice-president of the Chase Securities Company, New York, in charge of the supplies; William Cochran, New York City, assistant to Major Horn in transportation; H. Malcolm Pirnie, firm of Hazen, Whipple & Fuller, consulting engineers, New York, assistant to Major Whipple in military

sanitation; Henry S. Brown, journalist, New York, publicity.

The commission included men capable of giving judgment and planning action in any line of work likely to be undertaken by the Mission in Russia.

THE JOURNEY TO RUSSIA.

The journey to Russia and back to America was a remarkable experience. We left Boston and New York on June 29, and arrived in Petrograd on Tuesday, August 7, after a journey of nearly six weeks. Of this time, five days were spent crossing the American continent, three days in Vancouver and Victoria, ten days on the Pacific, eight days in Japan, one day on the Japanese sea, one in Vladivostok, thirteen days on the Trans-Siberian railway.

If time permitted, it would be interesting to tell in detail the story of this journey, of the magnificent scenery in the Canadian Rockies, of the Russian lessons, the setting-up drills, and the vaccinations on the *Empress of Asia*; of the wonderful address of Major Robins in the cabin which held us spellbound as he related the story of his life and his work in the Klondike; of the week in Japan, with its novel sights, its bountiful entertainments by the Japanese Red Cross officials, its side trip to Nikko, the Japanese dinner given by the celebrated Kitasato, and the final ride across the mountains to the lovely harbor of Tsuruga; of the beautiful moonlight sail across the Japan Sea, when the members of the Mission gathered on the deck and sang songs till midnight; of the hustle at Vladivostok to load the supplies; of the special Imperial train of thirteen cars once used by the Tsar, and including the very car in which, only four months before, he had presented his signed abdication to a committee of the revolutionists; of the interesting sights in Manchuria and Siberia, the swim in the Ingoda River, the magnificent Lake Baikal, six thousand feet deep, around which we traveled all one day; of the committee work in the staterooms during the long days and the poetry and the mock trials in the lounging-room during the short nights; of the speeches to the soldiers, and the cheering and the hugging and kissing at the station

platforms; of the enthusiasm of every one over the great land of Siberia, a land not of barrenness and hardship, but a great, beautiful, wonderful land, with fertile soil and splendid forests, — a land of cattle and pastures, a land of splendid folk, a land of promise. One could write a book of all this, but such books have already been written, and these things were for us merely by the way, for back of it all we realized that it was war time and we were on a war mission.

Finally we arrived at Petrograd. We were met at the station by Ambassador Francis and other Americans, and by representatives of the Russian Red Cross. In fact, although the Russian Government had furnished us with the Imperial train and military guards, the same train, by the way, in which the Root Commission had traveled east on their return to America, we had been the guests of the Russian Red Cross through Siberia. Representatives of this society had met us at Vladivostok, and acted as both guides and interpreters. For a few days the Mission made its headquarters at the Hotel de France, but later better and more permanent quarters were secured at the Hotel d'Europe, just off the Nevsky, in what is practically the center of the city.

THE RETURN JOURNEY.

The Mission remained in Petrograd for five weeks, although during this time side trips were made by some of the members to Moscow, to Ekaterinoslov, to Archangel, and to the west front of the army near Minsk. On September 11, Colonel Billings, with five majors, two lieutenants and two orderlies, left for America, leaving the other members in Petrograd as a permanent staff, to remain throughout the war or as long as their services may be required. A few of them have since started for America, but others have taken their places.

The return journey was even more delightful than the journey out. A special car on the regular weekly express took us to Harbin. It was September, and Siberia was yellow with grain, yellow also with the turning leaves of the white birch and Siberian larch, and we were more than ever impressed with the

resources of the land. We said, over and over, "This is a land of gold." Arrived in Harbin on September 21, we changed cars and crossed Manchuria, with its fields of tall kaoliang (millet, or Kafir corn), passed through Mukden, the seat of the great battle in the Russo-Japanese war, and reached Peking on Sunday, September 23. There we had a glorious week, every moment filled with sight-seeing and entertainment. These included luncheons by our American ambassador, Mr. Paul S. Reinsch; a formal dinner to Admiral Knight's party and our own, the ceremony of laying the cornerstone of the new Rockefeller Hospital, visits to the Forbidden City, the summer and winter palaces, an American dinner by Mr. Finch (a mining engineer associated with Colonel Thompson), and boundless courtesies from every American in the place.

Two of us went to Tientsin to speak at a Red Cross meeting, but instead of the meeting we investigated the great flood, and Colonel Billings and Minister Reinsch sent a cable to Washington in regard to American aid for the million homeless people. As a result of this, the American Red Cross Society sent over a large fund to be administered by Mr. Roger Greene. An extremely pleasant feature of the visit to me was that of meeting a former student, Surg.-Gen. S. H. Chuan, director of the Chinese Army Medical College. Dr. Chuan and several hundred of his students were all busy with relief work for the flood refugees.

The floods prevented our return via Shanghai, so on September 28 we went back through Manchuria, Korea and Japan. This gave us a day at Seoul. At Osaka we encountered the flood caused by the great typhoon which did so much damage in Tokyo. We were obliged to pass one of the great railroad breaks in boats for over half a mile.

We reached Tokyo October 4, sailed from Yohohama October 6, arrived in Vancouver October 15, and in Boston, October 20, after an absence from home of four months less one week.

POINTS OF INTEREST TO ENGINEERS.

I had opportunity to visit many engineering works. The mayor of Yokohama and the mayor of Tokyo extended the courtesies of the engineering departments of those cities. We saw the sand filtration plants in both cities, the new water supply and the proposed sewerage projects for Tokyo, the harbors, docks and shipbuilding plants. We visited the engineering school of the University of Tokyo, and I made an address to twelve hundred Japanese students at Aoyama College.

The Trans-Siberian Railway interested us. It is approximately 5 500 miles long, is substantially built, has a double track for perhaps a third of the distance. The double-tracked loop around Lake Baikal has been practically finished. This was heavy work, as it included over forty rock tunnels. The railroad stations and outbuildings are substantial and neat. The grades are heavy in places, the rails light, the driving wheels of the wood-burning locomotive small, the sidings infrequent and the operating sections small. Consequently, the speeds are low, station stops long, and the locomotive runs small. The present tonnage is far below normal; and freight has piled up at Vladivostok. It is said that, with changes in operation which can be easily made, the capacity of the road can be increased a third. But more rolling stock and more sidings, and ultimately a double track, are greatly needed. The engineers of the Stevens commission are now hard at work on this problem.

In Petrograd we found that the old sand filter of the water supply from the Neva had become outgrown and had been converted into an improvised mechanical filter, using bleaching powder and electrolyzed salt as a disinfectant. A new mechanical filter of German make, which involved the use of ozone, was in operation. This is perhaps the largest ozone plant in use, i. e., 13.5 million gallons a day. The engineer in charge is not pleased with it. It has proved to be very expensive, and is likely to be abandoned.

In Petrograd the sewers do not receive the solid fecal wastes. These are screened from the house drains at each house, collected in night soil carts, and carried to barges which dump them far down the river, or to a receiving station where they are

again screened through Reinsch Wurl screens and the solids burned in the adjoining refuse incinerator. The liquid portion of the house sewage flows to the sewers and is discharged through long outfall sewers, the storm overflow going to the canals.

At Moscow we found a most interesting sewage experiment station, one of the largest in the world, in which the latest methods of disposal, including activated sludge, are being studied by an able and enthusiastic engineering chemist, Dr. Serge Stroginov.

In China we were greatly impressed with the importance of the flood problem. It towers above all the other engineering needs of China.

The opportunities for engineering work of many kinds in all of these countries are tremendous.

RUSSIA AS WE FOUND HER.

On our way to Russia we had heard all sorts of disheartening rumors. "The government was unstable; there was no government at all; all the officials were resigning; the soldiers were walking the streets of Petrograd, committing all sorts of crimes; there was no police; the army was disorganized; the Germans were liable to take the city at any moment; there was no food in the city; the railroads were not running; Senator's Root party had been assaulted; bridges had been burned; there was small chance that we should ever reach Petrograd any way." But instead of that, our train moved steadily onward through a friendly population, through fields of wheat and rye rich with harvest, and we reached Petrograd just when the general in charge of the train said we would.

In Petrograd there were no crowds. There were plenty of soldiers, loafing, to be sure, and there was practically no police protection, but nowhere was there disorder, nowhere were any discourtesies shown; and wherever we went, whether among officials, officers or soldiers, or among the people on the streets, we received only marks of kindness. The trolley cars and trains were crowded with soldiers, for they claimed the right of riding free. On the Neva and on the canals boat traffic was slight,

and very little trucking was being carried on in the city, but during the five weeks we were there there was a change. Barges, chiefly loaded with fire wood, were seen discharging along the canals; the winter's fuel supply was growing; street traffic increased; the streets were regularly cleaned; troops were seen marching, and long supply trains went through. The food supply was short, especially bread, milk, sugar and butter. Prices were high, and as the rouble fell in value from $23\frac{1}{2}$ cents to 14 cents (the normal exchange is about 50 cents) prices went higher. Bread lines could be seen every day, also chocolate lines, cloth lines and cigarette lines. But there were no riots; the people appeared to be well nourished, well clothed and well shod. The patience and orderliness of the men, women and children, their respect for each other's place in line, was most conspicuous.

We of the Mission had food enough, but not always what we wanted. Often we had a meager breakfast. Sometimes it consisted of black coffee, with no milk, sugar or bread. At best it consisted of black coffee with black bread, jam, butter and sugar. The black bread was sour, but occasionally we got what was called white bread, although this epithet was applicable only by contrast or courtesy. Luncheons and dinners were much alike, and consisted of soup, fish, and veal, chicken or game bird, with compôte for dessert, which modest meal cost between \$2.00 and \$3.00 a plate, American money. One of our majors picked up this bit of conversation which very well illustrates the conditions. He met a gentleman of pronounced Hebrew profile and speech, who had just returned from a visit to the front. The major said, "I suppose you saw plenty of excitement there." The reply was, "I should say I did see plenty of excitement. I had to pay thirty r-r-roubles for my dinner, and zee next day it vas more, too." To offset the high prices, we paid no waiters' tips. Tips are taboo in a free country. The waiters regarded themselves as our equals, and would not condescend to take tips. They preferred to add 15 per cent. to the bill, and to be called "officiants." In short, we had no luxuries in Petrograd, but we had no hardships worth talking about.

One evidence of the revolution was the enormous number of

posters on the buildings. They covered the stores, the churches, the palaces, the bases of statues, the telegraph poles, the fences. Wherever a poster would stick, there it was pasted. This gave the city a very unkempt appearance. The old Russian flag was seen nowhere (although many think it will some day return), and in its place was seen the red flag of the revolution. This hung over public buildings, over the Peter and Paul fortress; while a small one had been placed in the hands of the bronze statue of Catharine the Great, in the park on the Nevsky. The old coat of arms, the double-headed eagle surmounted by a crown, had been stripped from public buildings, from signs and even from the railroad cars. In every way the people have tried to obliterate all recollection of the former hated government. Some of these attempts have been childish.

On the day following our arrival, an event occurred which did much to encourage us. This was the popular sale of liberty bonds. Petrograd was gala with booths decorated with flowers and bunting. Decorated automobiles and barges filled with young men and women went through the streets. There were bands and much enthusiasm. For three days the sale went on. The bonds were of small denomination, the cheapest being 20 roubles, or about \$4.00 at that time. People on the street bought in large numbers. Many soldiers bought them. It reminded us of our own Liberty Bond sale and of the collection of the Red Cross Fund. The scenes in Fifth Avenue, New York, as I saw them, could be duplicated on the streets of the Nevsky. We have since learned that as a result of the sale in Russia the sum of nearly four billion roubles, or about one billion dollars, was secured.

Another sight, both sad and inspiring, was that of the Woman's Regiment starting for camp on the way to the front. A thousand young women had been training on the grounds of the Technical School; but one day, at seven in the morning, they held an open-air religious service, and marched away in heavy marching order, with full packs and complete camp equipment. The young women looked like boys. They were very young. They were splendidly drilled. They were doing this not because men were scarce, but because so many men were loafing instead

of fighting; and no one can deny that the spirit of these young women was sincere and patriotic; but to see the mothers with tears in their eyes, following their daughters beside the outgoing column as they marched across the canal bridge towards the Neva, was a sight to bring tears to the eyes.

Best of all, however, we found Russia sober. Vodka has almost wholly disappeared. Just as in our prohibition cities and states, alcoholic liquors are sometimes obtainable, perhaps more freely in the country than in the city, but I doubt if half a dozen drunken men were seen in Petrograd during our five weeks there. Personally, I saw none. The only place where I saw liquor openly used was at the tables of some of the officers at the front, and in our presence it was not used to excess. What would have happened if universal prohibition had not preceded revolution it is easy to imagine.

RUSSIA'S PART IN THE WAR.

In order to understand Russia's attitude in the Great War, it is necessary that one consider her history during the eighteenth and nineteenth centuries. This was a period of contest between autocratic and democratic powers the world over. The American revolution, the French revolution, the peaceful liberalization of England, the struggle for freedom in Italy, were some of the more conspicuous of these contests. At the beginning of the twentieth century, Germany, Austria and Russia alone, of the great European countries, were autocratic. Austria, the stronghold of autocracy under the influence of Metternich, had become subordinate to Germany. Russia became more autocratic as her government became Germanized. When Peter the Great reached westward for his ideals of civilization, he brought to his country a new strength, but he also allowed to enter a people who, when the time came ripe, would strangle the nation and use its great resources for its own foreign ends. From the time of Catharine the Great to the time of the last Tsar, Nicholas II, the Romanoff blood has been mixed with the German. The Russian court and the bureaucracy has been growing increasingly Germanic, the business world of Russia has been Teuton-

ized, the natural raw materials of the country have been shipped to Germany, and the false rulers have blocked the way to popular education and freedom of the common people. Against this stone wall of autocracy, the people of Russia — democrats, nihilists, anarchists, alike — have beaten in vain, and death or exile has been their reward.

There was a time, up to the early days of Bismarck, when the Russian and German autocracies were willing to aid each other against the rising tide of democracy, but during the last generation, when Germany began to show her desire to alone denominate Europe and began to treat Russia as a rival autocratic power, the Russian rulers gradually drew away from Berlin. Needing capital, official Russia looked to France and England, and gradually there resulted a cordiality and then an alliance with France. Meantime the last attempt at revolution, after the Russo-Japanese war in 1905, had disappeared, and Russian autocracy appeared to be firmly in the saddle.

When Germany sprung the trap in 1914, Russia entered the war, and almost to the surprise of the nation autocratic Russia and democratic Russia found themselves united against a common enemy. This unanimity in Russia at the beginning of the war resulted in the early successes which accompanied the great drive. But the Russian nation was not really united. The autocratic Russian rulers thought they were fighting a rival power; the democracy of Russia — the common people — with less reasoning but with deeper instinct, realized that they were fighting autocracy itself, — that the Great War was not fundamentally a war of national supremacy, but a war for human freedom. After a time the Russian autocrats, who controlled the government, began to realize this, and they realized also that a Russian victory meant a bureaucratic defeat, while a German victory meant the continuance of their own autocratic power. What did they do? They deliberately wrecked their own nation. Aided by the Germans in Russia, they throttled their own army, they withheld supplies and ammunition, they sent men to the fighting lines without guns, they mobilized enormous numbers of men whom they could not equip, withdrawing them from industry, but failing to make them into soldiers; they dis-

organized the railways; they made laws which upset business, injured the credit of the nation, and made food riots inevitable. They betrayed their country in a more wholesale way than ever was a country betrayed before. Had they remained in power it is thought they would have concluded an independent peace with Germany, betraying their allies as well as their own people.

Fortunately the same spiritual uplift which rose in France, the stand which was taken by England at Germany's violation of Belgium, occurred also in Russia among the true Russian people. The so-called liberals, who were, as a matter of fact, relatively conservative, stood amazed at the betrayal of their country by those they had been supporting. Thus there occurred leveling and unifying changes which brought the Russian people against their rulers, and the result was the bloodless revolution, the overthrow of Tsarism, and the establishment of the present Russian democracy. At last the true Russian people had exerted themselves; they were trying to govern themselves; they were trying to drive out the German influence; they were trying to create a new and better Russia, and they were trying to do this under the greatest handicap that can befall a nation, — they were trying to do all these things with their country still at war.

The people of the allied countries are disturbed by the failure of Russia to carry on offensive operations against the enemy. It is a natural feeling, for the enormous Russian army lies to-day relatively inactive. Some say, "Oh, that the Russian revolution had waited until after the war!" If the revolution had not occurred, the war would have been already over, so far as Russia is concerned; England and France would have lost their ally, and America would have shouldered a far greater burden than she is now called upon to bear. Autocratic Russia was not a natural ally for the free nations of France, England and America; democratic Russia is their natural ally, and, unless underhand Germanic influences in Russia succeed, — and they are straining every nerve to succeed by fair means and foul, — democratic Russia will stand firm with the allied cause.*

* The underhand Germanic influences have recently succeeded in obtaining what I believe to be a temporary control of the government. — G. C. W.

THE RUSSIAN REVOLUTION.

There have been many attempted revolutions in Russia, but never until now were the conditions ripe for success. The foundations for a real democracy were laid in 1864, when the first Zemsvos, or local boards of government for provinces and districts, were established under Alexander II, who had also liberated the serfs. These Zemsvos undertook many important works, social and educational, and brought to the front men of public spirit. During the Russo-Japanese war, in 1905, the Zemsvos did much in the way of relief work, and their success had been such that in 1914 there was organized an All-Russian Zemstvo Union under the leadership of Prince George E. Lvoff. There was also organized a Union of Towns which joined with the Zemsvos. Moscow was the center of both of these movements; in fact, most that is truly Russian to-day centers in Moscow, the old historic capital of the nation, — center of its religion, its art, its commerce. Organized especially for war relief work in the interior, the insufficiencies of the old government made it necessary to carry on work at the front and to undertake so-called war industries, even the manufacture of ammunitions. It happened, therefore, that the united social forces of Russia became a powerful support of the war. Along with this, and in part caused by it, went a democratization of the army. Thus was the stage set for the revolution.

Then came the rascalities of the disgusting Rasputin, the intrigues of the Germanized bureaucracy, the muzzling of the press, the ban on the national assemblies, the retirement of the foreign minister Sazonoff (friend of the Allies), the treacheries of Sturmer and Protopopov, the deliberate demoralization of the commerce and the food supply, and the scandals of the army management. It became evident even to the members of the Fourth Duma, notoriously conservative, that the Russian nation was being betrayed to the enemy, and they united with the radicals and socialists in condemning the government. It was in November, 1916, when things began to move. Germany's peace terms were refused by the Duma on December 19. On December 30 Rasputin was murdered. In February, 1917, great confusion was caused by changes in the ministry. In February,

Protopopov tried to stimulate strikes so as to give him opportunity to use stern measures of repression, but he failed to appreciate the strength of his operation. A council of workmen was organized, and the soldiers joined with them. On March 10 the Tsar dissolved the Duma, but the Duma refused to disband. The next day there was a revolt in the army. Then the revolution broke. The people and the soldiers overpowered the police, opened the prisons, burned the police records, broke open the famous Peter and Paul prison, the Bastille of Russia, and seized the reins of government. By March 15 the Tsar had signed his abdication and a provisional government under the premiership of Prince Lvoff had been chosen by the Duma with the agreement of the workmen and soldiers deputies, the head of the Zemstvo Union, and with Paul Miliukoff, of the Constitutional Democrats, and Alexander Kerensky, of the Socialist party, as prominent members. The most amazing thing about the whole revolution was the small amount of bloodshed. It is true that people were killed in Petrograd, that machine guns swept the streets, that the buildings were burned, — the window of my room in the hotel had been pierced by a bullet, — but the damage, the confusion, the excitement, was largely confined to Petrograd.

And what have the Russian people done with their newly found liberty? They have done just what one might expect. At first they abused it in ways that seem childish. Each man wanted to be free. He said, Why should I work? I am free. Why should I pay for things? I am free. What need have we for police, are we not free? Why should we soldiers obey our officers? We are free; we will appoint committees in our regiments, and these committees will decide what we shall do. Why should we privates salute our officers? We are as good as they. Why should we waiters humiliate ourselves by taking tips from those we serve? We are as good as they. In many ways the Russians have acted as schoolchildren who have escaped from their teacher. They have done little, almost nothing, that is vicious; they have done much that is foolish, much that they will some day regret, and much that they will soon stop doing.

On the other hand, it is not surprising that, having dreamed

of freedom and struggled for freedom for generations, the actual coming of freedom should engross the thought of all the people, including the men in the army. "Now we will have education and be no longer the dark people; now we will have plenty instead of famine; now we will have land to own and cultivate." These are the thoughts which are uppermost in their minds, and it is all very natural.

Those who see these conditions of disorganization at the present time, with the country in a state of anarchy, before a constitution has been adopted, and are disturbed by them, should go back and read the history of the United States during what John Fiske called the critical period of its history, and the history of France during and after her revolution. Of course the lack of offensive military operations is greatly disappointing to the Allies, but when we think of what so nearly happened, or how, if it had not been for the revolution, we might have had Russia as an enemy, and not the friendly ally which she will undoubtedly continue to be, there is reason in America for great rejoicing that the revolution occurred.

Of course the divergent parties which united to overthrow the rule of the Tsar and the Germanized bureaucracy did not at once agree. After choosing the provisional government the Duma legislated itself out of existence, and since then all changes in the cabinet have been by agreement of the parties. There was no real authority for the government which we found in Petrograd. It was expected that a constitutional convention would convene in December, and that there would be an election of delegates, but the present uprising of the Bolsheviki may prevent this.

It is too early to write an account of the recent events in Russia. How far the Germanic influence has permeated the country, cannot be said at present. The present conditions are serious but not hopeless.

WORK OF THE MISSION.

We were greeted in Petrograd with no *éclat*. There were no official receptions. Many of the formalities vanished with the empire. We entered the most democratic democracy in

the world, and beside that, the only men worth seeing were so busy that there was no time for an exchange of mere courtesies. Our mission was to offer encouragement and Red Cross aid to the Russian nation in its prosecution of the war. The Root mission had already carried the greetings of the oldest to the newest of the republics. Our message was one from the people of America to the people of Russia.

The first moves were wisely made, and therein lay the secret of such success as we have had. On the day following our arrival, Colonel Billings, Colonel Thompson and Ambassador Francis called officially upon Kerensky, the head of the Provisional Government, and several members of the cabinet — then only four days old. The new surgeon-general of the army, Dr. Yuriavich, two weeks in office, was the natural head of the work in which we were interested, and he proved to be not only sympathetic but broadminded and efficient. A bacteriologist by training, he fully appreciated the nature of the help which we were able to offer. Through him, access was given to the various departments of the medical and sanitary service, to the hospitals, supply houses and the bureau of statistics. The officials in charge of these departments were found to be very able scientific men, and delightful acquaintances. Dr. Vreden, the great army surgeon; Dr. Novasselsky, the statistician; Professor Vladimiroff and his assistant Dr. Tarmox, were most cordial and helpful.

The mayor of Petrograd was called upon, and arrangements made by which the members of the Mission were brought in touch with the local health and relief work, the city hospitals, the water works, the bacteriological laboratories, the municipal markets, the bread distribution, and all of the many functions of the local Dumas. Dr. Bogorovitsky, Dr. Haffkine, Dr. Yakowleff, Dr. Stepanoff, Dr. Gamaleia, Dr. Mandelburg, were especially attentive and interested in our work.

The Russian Red Cross alone courted our attention. A meeting was arranged between the full membership of our Mission and the officers of the Society, and plans were made for complete inspection of the great work which is being carried on by them. The President, General Prokrovsky, and the chair-

man of the Committee on Depots and Supplies, General Ordin, deserve especial thanks for their courtesies.

The officials of the Zemstvo Union and the Union of Towns were visited in Moscow, and the local officials of Moscow were seen and the local relief and hospital work studied. Arrangements were made with General Korniloff, the generalissimo of the army, for us to visit the hospitals and inspect the sanitary work at the West Front.

It was found that many private agencies were at work, and that much welfare work was being done. Little by little the people in charge of these works were brought together. Calls were made upon many important persons not now holding official positions, such as Dr. Paul Miliukoff, the former minister of Foreign Affairs; the aged Prince Kropotkin and his active and public-spirited daughter, Madame Polisova; Lady Panine, and, of course, the world-famous grandmother of the Revolution, Madame Breshkovsky. The ambassadors of the Allied countries were called upon, and cordial relations established.

To all of these people, from the lowest to the highest, the story was the same. "We have come, not to any one organization in Russia, but to the Russian people; we have come not to sell supplies, not to give charity, but to find what you need and give it as a free gift of the American people; we recognize the great work you are already doing, but we are now your ally, and we have come to work with you throughout the war." It took some time for this message to be appreciated. Our first week in Petrograd was a lonesome one, but before we left the hours of the day were not long enough for the many interviews which took place. The Mission sought no newspaper publicity. It did seek, and actually secured, the cordial coöperation of the people who are at present in charge of the kinds of work in which we were most interested. In some directions we found our progress blocked, and in one field we were disappointed in not being able to accomplish more, namely, in the food supply of Petrograd. There we had to limit our activities to food for the infants. While we were there in Petrograd, we learned that the Stevens Commission, working on the transportation, had succeeded in getting authority to go ahead with their work, for

which they had been obliged to wait six weeks, and that Mr. Harte, of the International Y. M. C. A., had been given authority to go ahead with his work in the army. This Y. M. C. A. work in Russia is being actively pushed. A hundred or more American young men are on the way to Russia.

We arrived in Russia, therefore, at a time when the relations with America were becoming actively cordial and sympathetic.

No account of our work would be complete without mention of the great help of Prof. Samuel Harper, of the University of Chicago. His wide acquaintance with the Russian people and his knowledge of the language made him an invaluable interpreter and guide.

INSPECTION.

To tell of the many inspections of the hospitals, storehouses, workshops, laboratories and relief stations of various kinds, would be tedious, but they were invaluable in giving us an adequate picture of the work which has been and is being done by the Russians. It is wide of the mark to say that little has been done in the present war. The amount of work which has been done by the Russian Red Cross, by the Zemstvo Union, the Union of Towns and by the government itself, has been stupendous. Four million sick and wounded soldiers have been treated, two million seven hundred thousand of these passed through the hospitals in Moscow; thousands of hospitals, with an aggregate of over half a million beds, have been maintained; forty thousand first-aid packages a day were being turned out at the government shops; fifty million yards of gauze are on hand in the Red Cross stores; half a million hides were collected at the front and tanned. These figures serve to show the scale on which the work has been done.

The Russian scientists are splendidly educated, skillful and resourceful men. Some of them are splendid organizers. They do not need to be advised how to do things. In more ways than one we learned from them, rather than they from us. Nor are the Russian *Intelligencia* lacking in the spirit to do things. They have been handicapped by their badly organized government, by the deep-seated and far-reaching evils of graft among officials, and by an inertia born of these things.

Our inspections and interviews showed us that what the Russian scientists and officials need is not advice, but sympathy and encouragement; not an assumption of certain work by American men and women, but cordial coöperation, with here and there, in many places, help in obtaining the supplies which they cannot otherwise secure and which in some cases they very greatly need.

DISTRIBUTION OF SUPPLIES.

Our two carloads of supplies, hastily gathered together in a week's time and having a value in Russia of perhaps a quarter of a million dollars, included medicines, surgical supplies, microscopes and laboratory apparatus, antitoxins and vaccines.

These were housed in the storehouse of the sanitary department of the Russian army, this being under the authority which best represented the Russian people. After consultation and inspection of the needs, many of these supplies were distributed soon after our arrival. It was this free gift of supplies so greatly needed which touched the hearts of the Russians and gave them confidence in the message which we had brought from America. It was a spirit new to them, a spirit which they had not associated with America. On several occasions when we showed our lists of supplies and asked which of them they needed, the officials said, "We need these and these; now what do they cost?" The answer was always, "Show us that you need them, and they are yours as a free gift from America." On one occasion when this was told to an old physician in Moscow, his eyes filled with tears.

Of course the supplies which we carried did not anticipate every want, and of course many more supplies will be needed. It has been arranged, however, to send supplies at regular intervals. Russia needs many things besides those supplies which it would be within the province of the American Red Cross to send. She needs money, but she also needs shoes, and clothing; she needs manufactured articles of many kinds, tools, machinery, engines and automobiles; she needs all sorts of merchandise which the peasants can use or buy. With no supplies to purchase, no vodka to buy, with the rouble depreciated in value,

the peasants prefer to hold their grain, preferring it to money, and this is one reason why food is scarce in the big cities. The big cities have nothing to give in return. Russia as a whole has food enough for the present. The stimulus for distribution and the means of distribution must be provided.

ORGANIZATION.

The first work of the Mission was to deliver the message, the second to organize the work. The third will come later, — to furnish the supplies at regular intervals and carry on the coöperative work.

When we arrived at Russia we found that, while the four most important organizations engaged in medical work, namely, the Sanitary Department of the Army, the Zemstvo Union, the Union of Towns, and the Russian Red Cross, were working harmoniously at the front and doing work along parallel lines, there would be difficulty in properly distributing American supplies unless these organizations could be brought closer together. The Red Cross had received its support largely from the old régime, the Empress herself having been one of the strong supporters and the Winter Palace having been turned into a Red Cross hospital. The headquarters of the Red Cross was at Petrograd. The Zemstvo Union, on the other hand, received its support from the local communities throughout the country, the headquarters being at Moscow. Since the revolution, all of these organizations have received support from the government. After several weeks of interviews, these organizations finally joined together in establishing a joint committee, and hereafter the American Red Cross will have a stable body with which to transact business, one which will insure a proper distribution of the supplies furnished.

When Colonel Billings, with most of the specialists of the Mission, returned to America, seventeen men were left in Russia, this number being raised to about twenty by additional appointments. An office has been opened in Petrograd, and store-houses will be established.

DISCOURAGING FEATURES OF THE SITUATION.

The question in which America is immediately interested is, What is the Russian army going to do in the war? There are perhaps ten million men mobilized, but less than that are actually under arms and equipped for work at the front. Whatever the number may be, it is an enormous force; in fact, it is too large. To offset this, however, is the present disorganized condition of the army, due to its so-called democratization. The substitution of committee rule in regiments for the stern military discipline, the abolition of the death penalty, the lack of coördination of the work of the different armies, the uncertainty of the standing of the officers and their fear lest their actions may not be supported by the changing war ministers, the war weariness of the soldiers themselves, their interest in the new freedom, and especially the insidious influences of German propaganda have united in producing a condition which makes vigorous offensive operations unlikely if not impossible. The railways, governmentally operated, are disorganized; the military roads are bad; the sanitation at the front extremely unsatisfactory, and the amount of sickness great. These conditions are indeed disappointing. Yet, in spite of them, when we were there, the men in the trenches were still fighting, and the attacks of the Germans were being followed by counter-attacks of the Russians. As long as this sort of fighting is kept up, the Germans cannot withdraw troops from the Russian border to use elsewhere. Even though the Russian retreat here and there, if they hold their thousand miles of continuous trenches from the Baltic to the Black Sea there is no reason for the Allies of Russia to be discouraged. Furthermore, it appeared to us that already the nation was beginning to realize the necessity of stricter rule, of greater discipline. "We need discipline," some say, "but we want democratic discipline." Russia has lost Riga, she may lose Petrograd; but even with these losses Russia would still be Russia, and we heard the opinion expressed not infrequently that if Russia were compressed it would be to her ultimate advantage, as such compression would surely bring into action a counter force of great violence.

Looking ahead, too, there are things to be viewed with

apprehension. Official Russia has been honeycombed with graft. Not only government officers, but railway officials, even station agents and train conductors, have not hesitated to take their percentage from the unprotected public. The abolition of tips and other perquisites since the revolution is said to be having its effect, and one of our American consuls told me that he saw in this an important step towards the abolition of graft in high places.

The land question, however, is the great problem in Russia. Without doubt the great holdings of land by the state, the church, and wealthy individuals is wrong in principle. These great land holdings ought to be subdivided and ownership distributed. It is here where parties differ. Some would seize the land without compensation to the owners, some would take the land but pay for it in full, some would pay a part. Others want a complete socialistic control of the land. It may be years before this question is satisfactorily settled.

The greatest and hardest problem at present is that of meeting the German propaganda both in Russia and America. The mobilization of too many men made Petrograd a nest of loafing soldiers and furnished a rich soil in which to sow sedition. The German propagandists invaded the army, and said, "Go home and get the land which is being distributed." "You have succeeded in your revolution; soon there will be a revolution in Germany, so give up your fighting." "The American capitalists are now coming into the war for their gain and your loss." In America there is a steady attempt made to discredit Russia in our eyes. Unconsciously, perhaps, the press has encouraged a spirit of pessimism and resentment in regard to Russia and the Russians, undeserved by them and unwarranted on our part. Truthful news fails to travel in either direction. We do not get the facts straight from Petrograd; the Russians do not hear what we are doing. Relatively few in Russia understand the spirit with which America entered the war or the vigor and determination with which we are proceeding. The need of the hour is for America to speak loudly to Russia and give her words not of abuse but of encouragement, and to read the daily dispatches from Russia critically and sympathetically.

GROUNDS FOR OPTIMISM.

The outlook on the surface is highly discouraging, but a nearer and deeper look tends to make one take courage. It tends to make one appreciate what has already been done, and to feel that the situation is by no means hopeless.

I believe in Russia and have faith in the nation for the following reasons:

The real Russians, who are in the majority in the central part of the nation, and are also found scattered through the country, are sturdy, hard working, patient, kind hearted, courageous and likable. Illiterate, to be sure, but they have a longing for education. It is going too far to say they are ignorant. They have an idealistic and sentimental streak, but when given opportunity they become good thinkers, the best of mechanics, and in general substantial citizens.

There are in Russia not only great artists and musicians, but able scientists and able, patriotic leaders. We saw and talked with many of these men, and came to admire them. They are the men who will soon control the nation.

The Zemsvos, or local governing organizations, which have been in existence for fifty years, have built up a substantial governmental fabric capable of furnishing the basis of the new democracy.

The Russian Church has been democratized. Once the most autocratic of all churches, it has been completely changed since the revolution. It has been not only liberalized, severed from national political control, but purified. When one realizes the tremendous influence which the church has over this naturally religious people, it may be rightly argued that its influence for democracy and for law and order will do much to stabilize the nation.

The Russians have thrown out the Germanized upper class, — the Romanoffs and their satellite bureaucrats; they are now engaged in a struggle with the Germanized lower class, the extreme radical socialists, the Bolsheviki and Maximalists, a class which though noisy and treacherous is really a small minority, and confined chiefly to the large cities, especially Petrograd. With this Germanized element eliminated, reorganization of the

government will make visible progress. Petrograd is no more Russia than New York or Boston is America. Moscow is the center of the real Russian nation.

The resources of Russia are very great. With these resources the country should be able to pay its just international obligations.

The Russians subscribed generously to their own liberty bonds, and "Where your treasure is, there will your heart be also."

The Russians have suffered enormously in this war. They are not likely to give up that which has already cost them so dear.

The nation has abolished vodka, and I believe that Russia sober means a Russia saved.

RUSSIA AFTER THE WAR.

No nation can build up a stable government in a year, and with a nation like Russia, with a population of 185 million people, with an area of 8 600 000 sq. miles, with three quarters of the people illiterate, it will take many years for affairs to become really settled. The war will end before Russia becomes really stabilized. Then will come the great problem, and one in which America — and especially American engineers — will be vitally interested. Can Russia become organized commercially and financially so as to develop as she ought without external aid? Those who have studied the situation say "No." After the war, then, whose and what influence shall be of greatest benefit to Russia? That Germany hopes to control the country for German gain is obvious. She has been trying to do so for a hundred years. I believe that in this she will not succeed, unless she too becomes a liberal nation. The feeling against the Germans among the real Russians is too strong. Autocratic Germany has overreached and lost. Liberal Russia will not tolerate an autocratic Germany.

Shall Japan be the outside power to influence Russia? She, like Germany, is near at hand; she has interests in eastern Asia which closely touch those of Russia. Manchuria is a debatable

country, in which Russia, Japan and China are all interested. Japan is rapidly developing the instinct of organization which Russia needs. Shall Japan be the nation to help Russia organize? Admirer, as I am, of the self-improvement of the Japanese, of their wonderful capacity for organization, I do not believe that it would be for the interest of Russia or of the world's peace that Japan should do this. I do not believe that at present Japan could help Russia with unselfish motives.

There remains England and America, and especially America. England is already helping Russia. There is already an Anglo-Russian Commission planning to carry on various educational and commercial enterprises intended to bring the Russians and the Anglo-Saxons closer together. But it will be difficult even for England to be entirely unselfish in giving this help. Of all the nations on the earth, America can help Russia most.

Our past relations have been friendly, our mutual interest in democracy is strong, and national traits are not unlike; we have no adjacent frontiers to cause difficulties between us; we can have no possible conflicts as to territory, but we can give what Russia needs and Russia needs what we can give, — sympathy, moral and political support, educational help, financial capital, commercial dealings, trade.

Russia must build herself up by the slow process of education and self-improvement. With the fetters of a crushing autocracy removed, the natural ability of the Russian people will exert itself and Russia will become one of the great centers of civilization. What Russia can be is well shown by that small part of her population known as the *Intelligencia*. There are no better scholars, no finer gentlemen, in the world than are to be found in Moscow. We have already come to appreciate Russian music, Russian literature, and Russian science, but in our ignorance we have looked askance at the common people of Russia. We need to learn that their faults are our faults, that they have a great capacity for self-improvement, and that except as climatic and geographical conditions hold them in check they are bound to forge ahead and play a notable part in the world's future.

AMERICA'S OPPORTUNITY.

Looking ahead, we see in this great land a wonderful opportunity for America and American engineers to aid in the development of natural resources and the advancement of civilization of the world. The journey back and forth across Siberia cannot fail to be a revelation and an inspiration to any American who has constructive imagination. The vacant plains have a soil rich enough to supply grain for the world; the virgin forests of splendid timber cover tens of thousands of square miles; the mineral resources are almost untouched. Siberia, once regarded as a land of exiles, will some day become filled with prosperous farmers; cities will spring up on the great rivers; there will be railroads and water power and manufacturing; and there will be schools and universities, and all that makes for a high civilization. Even in European Russia there are great natural resources undeveloped, fertile land, and coal and oil and mineral wealth. Nowhere in the world will there be greater opportunities for the young men of America than in Russia.

At the present time, the young men of America do not know Russia. During the last few years their eyes have been turned towards South America, and they have taken to the study of Spanish as a preparation for future commercial enterprises. In the same way they should prepare themselves for commercial enterprises in Russia by the study of the Russian language. It is true that this language is more difficult to an American youth than is Spanish, and the college men of America are not prone to choose a difficult subject when there are easier ones to be had; but, if the difficulties in Russian intercourse are greater, the prizes are also greater.

In order that America may help Russia in the right way, our universities should strengthen their Slavic departments. Students should be encouraged to study the Russian language. Russia should be studied not only for its literature and its history, but for its economic possibilities. I should like to see a well-endowed chair of Russian economics in Harvard University. Such a chair would greatly stimulate the study of the Russian language. There should be an interchange of university professors between America and Russia. Provision should be made by the Russian government for scholarships to be given to the

young men and women of Russia in American colleges. There is also much for American students to learn in Russia.

Russia needs practical, technical education. In her existing Germanized universities and technical schools, theory is carried to absurd limits, the applied sciences are neglected, the laboratory method of instruction is not used. England and America should immediately take up this problem of technical education in Russia. Good text-books on technical subjects are lacking. These must be supplied by us. Many of our text-books might well be translated into Russian. Russian students are ignorant of American progress. We should arrange to have more daily news, more magazines, more technical journals and reports scattered through the country. Russia needs laboratories of all kinds, — chemical, mechanical, electrical, mining. Russia needs better medical courses. Sanitation in Russia is at a low ebb. Few cities have public water supplies and sewers. Most of all, perhaps, Russia will need teachers for her elementary and secondary schools. It may be necessary for America to help in this field also.

The present physical needs of Russia are likewise great. She needs tools of all kinds, especially farming tools, and factories for making tools; she needs the basic industries of steel making, steel working; she needs locomotives, cars and equipment for her railways; she needs the chemical industries; she needs manufactured articles of all kinds, boots and shoes, clothing.

Russia needs capital and financial assistance. She must have outside aid to develop her natural resources.

All these things America can give. But America must not do as Germany has done. German development always placed Germany first. America must place Russia, not America, first. Reasonable profits in Russian investments can and ought to be expected. With a liberal Russia and a stable government, Russian investments will be safe. Between Russia and America there is ample opportunity for profitable trade, profitable on both sides; ample opportunity for unselfish and rewarding service in many directions; ample opportunity for America to give the world a demonstration of that international good-will which must be the safeguard of the world against a repetition of the present awful war.

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WATER POWERS OF NEW ENGLAND.

BY HENRY I. HARRIMAN.*

(Presented October 17, 1917.)

CONSERVATION and efficiency are the passwords of the twentieth century. Conservation deals with the creation of effort, efficiency with its application; and together they symbolize the fundamental philosophy of our time, namely, that all energy and effort should be created in the most economical way, and applied in the most useful manner. Efficiency and conservation deal with all classes and kinds of human and mechanical effort, but they are particularly associated with the generation and application of power, and in this special field the use of electricity has become almost synonymous with efficiency; and its generation by water has, at least in the popular mind, become associated with conservation. It is therefore particularly fitting that we should briefly consider the utility and value of our very great water-power resources.

The use of water power in New England dates back to its very earliest history. John Alden owned and operated a water mill near Plymouth, and near Little Compton, R. I., can still

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be seen the old Peregrine White mill, owned by and named after the first white child born in New England.

Our forefathers in coming to this country were dependent upon their own efforts to raise their own food and build their own shelter, and among the first necessities of life that confronted them was the ability to grind their corn and wheat into flour, and to saw the timber from which to make their homes.

They were familiar with the gristmills and the sawmills of England, and well understood the construction and operation of primitive dams and water wheels, and the use of the energy of falling water. It was therefore natural that our streams should have been put to useful labor in the very earliest Colonial days.

So vitally necessary to the life of the community did these water mills become that, within seventy-five years after the landing of the Pilgrims at Plymouth, two of the colonies had evolved the principle of the Mill Act, — a principle entirely unknown to the common law of England, — which gave to the owner of a dam-site the right to flow out the land of his neighbor in order that water power might be created.

With this limited right of eminent domain thus early created, there also went a limited duty of public service, and in early Colonial times definite rates were sometimes established by law for the grinding of grain and the sawing of logs. The establishment by law of definite rates was, however, unusual, and more frequently the water mill was coöperatively owned and operated by the largest timber owners of the district. The opportunities for the development of power were, however, so many, and coöperatively owned mills so numerous, that all vestige of public regulation ceased long before the outbreak of the American Revolution.

The doctrine of the English common law, that the riparian owner on a non-navigable stream owned the bed of the river to the center of the stream, has always been accepted in our New England states, as has also been the right of the owner to construct dams upon his land, this right being subordinate, however, to the right of all owners along a water course to have the water flow by in a reasonably uninterrupted manner, and to the rights of the public to float logs and to exercise certain other public privileges.

The invention of the cotton gin, the loom and the spinning jenny ushered in a new era in manufacturing, and greatly increased the demand for mechanical energy, and whereas, up to the beginning of the nineteenth century, the use of water power has been very largely limited to the making of flour and lumber, with the advent of the new century there was witnessed a very great increase in the development of our streams for the operation of cotton and woolen mills, and associated industries. The process of manufacturing paper from ground wood was also discovered and developed, and a large amount of power so utilized. It is true that the steam engine had been invented, coincidentally with the other great inventions that signaled the close of the eighteenth century, but it was still a new and crude mechanism, and its use very limited. In fact, it is fair to say that up to 1850 ninety per cent. of the power required by our industries was derived from the energy generated by falling water.

New England has always been prominent as a center for all kinds of manufacturing. Her rugged coasts and barren hills, and the relatively poor soil, did not lead to such extensive development of agriculture as took place in our middle and southern states; and her trend was naturally toward the manipulation rather than the growing of the raw products which could better be raised elsewhere. Hence there sprang up, around her more important and accessible water falls, great manufacturing centers, such as Lowell, Lawrence, Lewiston, Manchester, Holyoke and many other and smaller towns.

It was not then possible to carry power any material distance from the site of the fall. The industry must go to the water power and not the water power to the industry. In fact, there is hardly a single manufacturing city of any size in New England whose origin cannot be traced back to the development of some waterfall within its limits. Manufacturing was started in New England long before coal was used, before the locomotive was thought of, and almost before the steam engine was invented; and the use of water power was universal as a source of energy until the close of the first half of the nineteenth century. Then, as manufacturing facilities increased and as the more desirable water powers were completely utilized, and as the efficiency and

reliability of the steam engine increased, our manufacturers turned from water power to steam power, preferring to locate their mills and factories on the seaboard, or in large centers of population where labor conditions were best, rather than to follow the courses of the streams back into the high hills. For nearly forty years water-power development in New England was neglected. Then with the development of the art of electric generation and transmission it became possible to bring the power to the manufacturer, and to have the double advantage of locating in the large centers of population and of utilizing cheap power generated by water.

The beginning of this century was marked by a great development of the more remote water powers of the country, and the transmission of electricity therefrom to the large centers of population. In the New England states, however, the largest and most conspicuous water powers had been developed and utilized long before the advent of electric transmission, and therefore the first great distribution systems of the country were built in the western and southern states. The Pacific Coast was a pioneer in this class of work, largely because of the scarcity and high price of coal, and the first transmission line to exceed fifty miles in length was built by the predecessor of the Pacific Gas and Electric Company, extending from the foothills of the Sierras into San Francisco. Another step in electric transmission was marked by the building of a line 150 miles long from the Kern River to Los Angeles, while the recent construction of a line to that same city spanning 250 miles marks the maximum transmission distance thus far attained. Extensive electric transmission systems have also been constructed in the southern states, the Southern Power Company having a network of between four and five hundred miles of line which link together nearly all of the larger manufacturing centers of North and South Carolina.

While it is true that many of the large water powers near the greatest centers of population in the New England states were developed long before the advent of electricity, it is still true that few sections of the country offer greater opportunities for hydroelectric development and transmission than our own New England states.

An interesting computation has been made as to the theoretical amount of energy which might under ideal conditions be generated by water. On the assumption that the average run-off in New England is 18 ins., that its area is approximately 60 000 square miles, and that its average elevation above sea level is 900 ft., it is computed that it would be theoretically possible to develop, for three thousand hours of each year, 15 500 000 horse-power, this being equivalent to the use of 52 000 000 tons of coal annually. Of course such a computation is nothing but an interesting mathematical calculation. It is, however, entirely possible that ten per cent. of this theoretical power may some time be developed from its streams, and that New England may be able to produce energy equivalent to that which can be produced from 5 000 000 tons of coal.

In the New England states there are eight large rivers with very great fall, namely, —

The Penobscot, with a total fall of	1 500 ft.
The Kennebec, with a total fall of	1 000 ft.
The Androscoggin, with a total fall of	2 200 ft.
The St. Croix, with a total fall of	400 ft.
The Saco, with a total fall of	1 900 ft.
The Merrimac, with a total fall of	269 ft.
The Connecticut, with a total fall of	2 000 ft. and
The Housatonic, with a total fall of	900 ft.

These rivers drain 35 000 out of the 60 000 square miles of New England, and, because of their great watershed and large drop, are its greatest sources of present and future power. Along these rivers are found our greatest water-power developments and our greatest manufacturing centers.

An estimate has also been made by the Bureau of Corporations, showing that in the six New England states there is now developed and in use over 600 000 horse-power of water energy, but that these same water-powers if properly reconstructed along modern scientific lines could generate an additional 200 000 horse-power. The same report shows that there is possible of creation in the New England states a minimum water-power development of 1 000 000 horse-power, which, by storage and by the utiliza-

tion of some of the less desirable powers, can be ultimately increased to 2 000 000 horse-power. The state of Maine leads, both in developed and undeveloped water-power, having a maximum possible development of nearly 1 000 000 horse-power; the power of New Hampshire, Vermont and Massachusetts is reckoned between 200 000 and 300 000 horse-power each; Connecticut has 160 000 horse-power, and Rhode Island ends the list with a possible 16 000 horse-power.

There is little doubt that New England can absorb all of the water-power which can be developed within its limits, for it is one of the greatest and certainly the most diversified centers of manufacturing in our country. The Census Department gives the total value of all the manufactured products of the United States at \$20 000 000 000 per year, and the six states east of the Hudson, with approximately 2 per cent. of the area of the country and about 4 per cent. of its population, produce over 10 per cent. of this great total. The boots and shoes manufactured in New England are valued at approximately \$300 000 000; its cotton mill products are worth an equal amount; its woolen mills produce goods valued at \$200 000 000; and its paper mills add to this an additional \$100 000 000 of product. It is also interesting to note that in no other section are there so many small manufacturing concerns. Massachusetts alone has over 8 000 separate manufacturing companies, the total in the New England states being in excess of 12 000, and while centralization in the ownership and control of industry has been most marked in our middle and western states, in New England there has been an actual increase in the number of productive concerns and a decrease in their average size.

The mechanical and engineering problems connected with the development of water power and with the transmission of electricity therefrom, to any distance up to 200 or even 250 miles, may be considered solved, and the question to be settled is now one of commercial feasibility. The generating of electricity may properly be considered a form of manufacturing, water being the raw product, and electricity the resultant; but it differs from ordinary manufacturing in two important essentials. First, electricity cannot, to any material degree, be stored

or kept for future use. It must be used when and as it is manufactured. In the second place, it can only be transported over wires reserved for its particular service, and its market is therefore limited to the industries which are located within reasonable transmission distance. Conceive, if you can, the difficulties which would face the manufacturer of woolen cloth who must manufacture his goods and deliver them on the same day, who must use his own trucks for the delivery of his own cloth, being denied the use of railroads and other means of transportation, and whose only market lay within a radius of 200 miles of his plant; and yet such is the problem that faces the manufacturer of electricity.

While great difficulties confront the manufacturer and seller of electricity generated from either water or coal, yet few lines of industry offer greater opportunities if wisely and conservatively managed. Of all the forms of power, electricity is the most transportable, and within reasonable limits can be cheaply carried from the place of generation to the place of use. Again, electricity is the most transmutable of all known forms of energy. It can be easily transmuted to the form of light; it can be changed into the form of the most intense heat for use in the electric furnace; it can be applied to the locomotive to give tractive power; it can be changed into mechanical energy for the turning of the wheels of industry. In fact, no other form of energy can be so easily transmitted from place to place, or so easily applied to useful work.

Despite the wonderful growth in the generation and use of electricity within the last decade, it is still fair to say that the electrical industry is in its infancy. For instance, it has been demonstrated that in many cities carting and teaming can be more cheaply done by the electric truck than by the horse-drawn vehicle, and it is estimated that, if the horse-drawn teaming of New York City were to be done by the electric truck, the amount of electricity required would exceed twice the present output of the New York Edison Company.

Electricity as applied to railway transportation is just beginning to prove its reliability and its feasibility. Already seventy-five miles of the New Haven Railroad, passing through

one of the most densely settled sections of the country, is operated by electric locomotives, and the St. Paul road is electrifying over four hundred miles of its road west of Butte, Mont. Wherever railroads have been electrified, much benefit has resulted, both to the corporation and to the public. It has been possible to give a more frequent train service without added cost; there has been great saving in coal, and even a greater saving in maintenance and upkeep; the strain upon the roadbed is less serious; the smoke nuisance is eliminated, and loss from fires set by locomotive sparks has entirely ceased. These advantages are so important there is little doubt that a very great amount of railroad electrification will take place as soon as financial conditions warrant.

The great extent to which electricity is being used for electrochemical purposes is hardly appreciated, yet two thirds of the energy generated by all of the companies at Niagara Falls is now so utilized. In fact, the number of kilowatt hours consumed in the electric furnace to-day exceeds that generated for light and power in the five largest cities of the country, and yet the possibilities of this industry are but faintly appreciated, and we smile at the prophecy of the scientists that the fertility of the earth will be maintained by the nitrogen abstracted from the air by means of the electric arc.

The manufacturer of electricity can also to a very great degree claim exemption from the serious labor problems which face so many other forms of industry. A modern hydroelectric plant with its distribution system does not spend more than ten per cent. of its gross income in the employment of labor, whereas the railroad and the trolley must so expend about fifty per cent. of its gross receipts, and many manufacturing industries must pay out seventy-five per cent. of their gross income for human effort.

In a comparison of the operating costs of a steam and a hydroelectric plant, the ultimate effect of the sinking fund upon the cost of power is not fully appreciated. No one would question the great advantage of the hydroelectric plant over the steam plant if the former could be had without cost, that is, without capital outlay; if its cost were \$50 per kilowatt, its

advantage would still be unquestioned; at \$150 its value might be debatable, and at \$1 000 every one would condemn it. In fact, the relation between the water-power and the steam plant is almost entirely dependent upon capital cost of the former.

If it is assumed that each kilowatt of machinery in a hydroelectric plant (costing approximately \$150) produces 4 000 kilowatt hours per year, and if it is further assumed that one mill per kilowatt hour is put into a sinking fund and reinvested in the six per cent. securities of the company, the fund thus created will have reduced the cost of the plant from \$150 to \$100 per kilowatt at the end of the tenth year; at the end of the sixteenth year its cost will have been lowered to \$50, and by the end of the twentieth year the plant will have been entirely paid for, and the company owning it will be in the very desirable position of being able to operate a hydroelectric plant without capital charge, and with very slight running expenses.

The economy of generating and distributing electricity in great quantities is now so apparent that no time need be given to its demonstration, and while it is true there are certain industries which require such large amounts of steam for industrial purposes that the central station can never hope to serve them, they are in the great minority, and, of the 1 500 000 horse-power now used in New England for manufacturing purposes, at least 1 000 000 horse-power may and probably will at some time be secured by the electric company. No manufacturer who can buy electricity at a rate equal to or less than its cost if made in his own plant will desire to make expenditures for boilers and engines when that same investment in productive machinery will bring in much greater returns. The big central station is here, and it is here to stay; it will grow larger and larger, it will be located at the best place, and from it will radiate lines which will carry energy for lighting, for trolleys, and railroads, and for every other form of industry.

Assuming, then, that the great generating plant, with its network of transmission lines, will supply the energy of the future, the question is often asked as to the relative value of and the relation between the central stations which produce their energy by water and those that generate power by steam,

and this involves a consideration of the relative costs of water powers and steam stations, the ability of each kind of station to carry peaks and loads of high load factor, the requirements of the water-power for auxiliary electricity during seasons of low river flow, and the ability of the steam station to supply this need without added capital expense.

A modern and efficient steam plant of large capacity can, under normal conditions, be constructed at a cost of from \$50 to \$75 per kilowatt of installed capacity, while a hydroelectric plant will cost from \$100 to \$150. Also, the hydroelectric plant must, in many cases, be located much further from its market than the corresponding steam plant, thus adding to its relative cost. It is therefore fair to assume that the first cost of the water plant will be at least double that of the steam station. But while the cost and consequently the interest on the investment is double, the depreciation and maintenance charges (expressed in percentages) are much less, as there is practically no depreciation or upkeep for water rights, dam or power house, and water wheels and slow-speed generators depreciate less rapidly than boilers, stokers and high-speed turbines. It is probably fair to assume that, while the fixed charges — which will include interest, maintenance and depreciation — on a steam plant will be 15 per cent., the corresponding expenses in connection with a hydroelectric plant will not exceed 11 per cent. Thus, the fixed charges on a steam plant costing, say, \$65 per kilowatt will be \$9.75 per year, whereas the corresponding charges on a hydroelectric plant costing \$150 will be approximately \$16.50, the balance being \$6.75 per kilowatt per annum in favor of the steam plant. The operating expenses of the hydroelectric plant are of course very much less than the corresponding costs for the steam plant. One-half mill per kilowatt hour is a liberal allowance for a water-power plant of large size, whereas the corresponding operating charges of the large steam plant will run from 4 to 10 mills per kilowatt hour, the variation in steam cost resulting from difference in the size of the plant, its load factor, and its efficiency.

Most successful hydroelectric plants are so designed that their forebays or ponds will hold the average flow of the stream

for from twelve to twenty-four hours. It is also usual for such plants to have a very much larger capacity of machinery than is required for their average output, as additional machinery can usually be added with a proportionately small increase in outlay; and this combination of the ability to hold the daily flow of the stream and utilize it during the exact hours of the day when most required, and to have large capacity at low cost, makes it possible for the water-power plant when run in conjunction with the steam plant to take the winter peaks and the daily swings in load most cheaply and economically, it being far easier to throw on an additional water wheel than to start up extra boilers and steam turbines. Again, the steam plant is of necessity relatively inefficient during parts of the night and on Sundays, when the load is small, but when steam and water plants are run in combination, the load can be so divided between them that each plant will carry the load during the times of the day when it can be most efficiently operated. Finally, the water plant during the seasons of the year when the stream flow is large has the ability to carry an output of high-load factor at very low cost, there being no added cost for fuel because of the increase in load factor.

Most of our large New England streams vary greatly in their maximum and minimum flow. For instance, at the Vernon plant of the Connecticut River Power Company the flow varies from a minimum of 1 500 cu. ft. per second to a maximum of 150 000 cu. ft., the maximum flow being one hundred times the minimum. It would not be profitable to make such a development on the basis of the minimum run-off of the river, and in the plant in instance its primary output requires a flow of about 3 500 cu. ft. The extremely low flow of course occurs only on a relatively few days, and in an average year the plant will have sufficient water to carry its full load for nine months, the actual number of kilowatt hours required from steam being about 3 000 000 out of a total annual output of 50 000 000 kw.-hr.; that is, from five per cent. to six per cent. of its load.

It is stated on reliable authority that one half of the capacity of our central stations is idle ninety-five per cent. of the time, but whether this exact percentage is correct or not, it is certainly

true that every such station must have a very great spare capacity during much of the year; and, fortunately for both the steam and hydroelectric plants, the periods of low water occur during the summer and early fall, when the central station load is at its minimum. Thus the central station can supply the deficiencies of the hydroelectric plant without any increase in installed capacity or fixed charges, and in doing so it will increase its load factor and decrease its unit operating cost.

All of these facts lead to the conclusion that the large steam plant and the large hydroelectric station can develop side by side, each caring for the service to which it is best suited, and each giving to the other economies which neither could have alone.

Among the large hydroelectric developments in New England is the plant of the Rumford Falls Power Company on the Androscoggin River at Rumford, Me.; the plant of the Androscoggin Power Company on the same river, near Lewiston; the plants of the Cumberland County Power and Light Company on the Saco River near Portland; the plants of the Bangor Railway and Electric Company near Oldtown and Ellsworth; the plants of the Central Maine Power Company near Waterville; the plant of the Turners Falls Company on the Connecticut River at Turners Falls, Mass.; the plant of the Connecticut Power Company on the upper Housatonic; the plant of the Connecticut River Power Company on the Connecticut River near Brattleboro; and the plants of the New England Power Company on the Deerfield River. These various plants have an aggregate capacity of about 250 000 h.p. Nearly all of them have been constructed within the last five years, and indicate the rapidity with which our streams are being utilized and their energy transmitted to distant cities and towns.

Very considerable progress has also been made in the development of storage and the consequent conservation of the flood waters of the spring. A dam at the outlet to Moosehead Lake impounds a total in excess of 30 billion cu. ft., and is capable of more than doubling the minimum flow of the Kennebec River at Augusta. Storage reservoirs on the Rangeley Lakes and in the upper waters of the Androscoggin have assured a minimum flow of 2 000 sec. ft. at Rumford Falls and Lewiston,

and a reservoir created in Somerset, Vt., is now storing enough water to produce in existing plants approximately 25 000 000 kw.-hr. which would otherwise be wasted.

We have considered, thus far, the hydroelectric developments in their relation to immediate and present industrial conditions, but their development should also be considered from the broader standpoint of the conservation of human energy and the liberation of human effort. The water-powers of New England are to-day producing more than 2 billion kw.-hr. of energy, which are utilized for the operation of manufacturing plants, for the production of light, for the motive power of trolleys and railroads, and for other purposes. If this energy were produced by coal, it would mean the annual consumption of 3 million tons, worth about 15 million dollars, and to produce, handle and transport this coal would require the continuous labor of 30 000 men, working three thousand hours a year. Thus the development of our own home water-powers makes it possible for 30 000 men to turn their efforts to other channels of industry and to the production of wealth in other forms. Less than this number of men dug the Panama Canal in seven years, or in the same period could have built a double-track railroad from New York to San Francisco. Therefore there can be no doubt that the utilization of our water resources stands on a par with the great inventions and discoveries of the age. Eli Whitney invented the cotton gin, and made it possible for one man to do fifty men's work. Hargreaves, Arkwright and others invented and perfected our cotton and woolen machinery, and gave power to one weaver to produce more cotton and woolen cloth than could one hundred weavers, one hundred years ago; and likewise the great inventions in the electric industry have made it possible for one man at the switchboard of a hydroelectric plant to draw more energy from nature's storehouse than could one thousand men a century ago. And while we may discuss the relative merits of this development or that, or the advantages of the steam engine, Diesel engine or water wheels, in the long run we may feel sure that the energy of falling water will be utilized to the fullest extent and that the powers of our streams will be made to do useful work for the benefit of mankind.

MEMOIRS OF DECEASED MEMBERS.

JOSEPH PHINEAS DAVIS.*

PAST PRESIDENT AND HONORARY MEMBER BOSTON SOCIETY OF
CIVIL ENGINEERS.

DIED MARCH 31, 1917.

JOSEPH PHINEAS DAVIS was born in Northboro, Mass., April 15, 1837, the son of William Eager and Almira L. (Sherman) Davis. All the lines of Mr. Davis's ancestry lead back to men and women who came early to New England, and many of them were active and efficient in the establishment of our institutions. On the paternal side he was descended in the seventh generation from Capt. Dolor (or Dollard) Davis and Margery Willard, who came to New England in 1634 with Mrs. Davis's brother, Major Simon Willard. On the maternal side he was descended from Capt. John Sherman, who came to America in 1634 and settled in Watertown, Mass. Captain Sherman became town clerk, selectman, representative to the General Court and ensign. He was also steward of Harvard College and a captain of the militia.

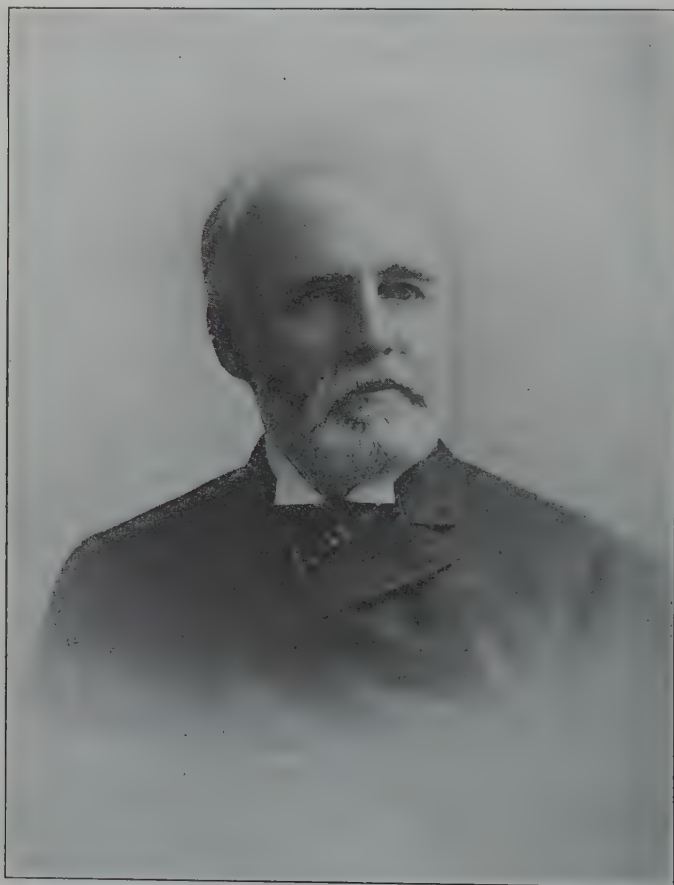
A brother of the grandfather of the subject of this memoir was the Hon. John Davis, for four years the governor of Massachusetts and for fourteen years United States Senator.

Mr. Davis's father died about four months before his son, Joseph, was born, and eight years later his mother married Israel C. Rice, of Boston. Mr. Davis never was married.

Mr. Davis was graduated from the Rensselaer Polytechnic Institute in 1856, and in the same year became assistant engineer on the construction of the Brooklyn, N. Y., Water Works, where he continued until 1861. From 1861 to 1865 he was topographical engineer for the government of Peru. In 1865 he returned

* Memoir prepared by Frederic P. Stearns and Edward W. Howe.

to the Brooklyn Water Works. In 1866 he became chief engineer of the Brooklyn Park Commission. From 1867 to 1869 he was principal assistant engineer of the St. Louis Water Works. In



JOSEPH PHINEAS DAVIS

1870 and 1871 he was chief engineer of the Lowell, Mass., Water Works. In November, 1871, he was appointed chief engineer of the Cochituate Water Board, to investigate and report on an additional water supply for Boston. After making a thorough investigation of all sources available, he recommended taking

a supply from the Sudbury River. Works for this purpose were carried out under his direction and completed in 1880, within his estimate of cost, which was approximately \$5 000 000.

In 1872 the office of city engineer of Boston became vacant, and as there were differences of opinion in the city government as to the engineer to be elected to this office, the matter was referred to a commission of prominent engineers, who reported recommending the selection of Mr. Davis, and his election followed. The commission in its report, after referring to the qualifications of other candidates, said:

"Mr. Davis, in addition to a thorough special education as an engineer, has had a more varied and valuable professional experience than either of the other gentlemen. Especially in that branch of his profession which relates to the supply and distribution of water, and water work generally, does he appear to be eminently qualified. He has filled important positions upon several works of great magnitude, and of others he has had the full responsibility as chief engineer. The testimony of engineers of the highest professional reputation is fully given to his capacity and attainments, and to the excellence of the work he has done. As the final result of their examination and inquiry, the board are unanimous in the opinion that he best embraces the qualifications most important for the discharge of the responsible duties of city engineer."

It is to be noted that at the time of his election his age was thirty-five years. He was city engineer only from 1872 to 1880, when he resigned to accept a more important position, but during that comparatively brief time he completed an additional water supply for Boston, and, after visiting Europe and studying the sewerage systems of the larger cities, planned and began the construction of the comprehensive works for improved sewerage, now called the Main Drainage Works of Boston; but this was by no means the extent of his achievements in this position. He at once established the engineering of the city in all departments under his charge on a thoroughly sound basis.

At the time of Mr. Davis's election as city engineer, the office had been organized only three years. His principal assistants were a group of young men who were extremely fortunate in having the benefit of the excellent engineering training which

Mr. Davis could give, and in being subject to the remarkable influence which he had upon those with whom he was associated. He was thoroughly appreciative of the endeavors of his subordinates to do good work, and there are many of them who recall with pleasure and gratitude the time spent in service under his direction. Not only were these subordinates so greatly benefited by association with him, but they became so imbued with his views and methods that long after he resigned as city engineer his influence was a controlling factor in the conduct of the engineering work of the city.

Mr. Davis was chief engineer of the American Bell Telephone Company and its successor, the American Telephone and Telegraph Company, for twenty-five years, from 1880 to 1905, when failing eyesight compelled him to retire. During this time his duties with the telephone company were not confined to his position as chief engineer. He was vice-president and general manager of the Metropolitan Telephone Company of New York from 1880 to 1886, president of the Hudson River Telephone Company from 1889 to 1895, and of the Westchester Telephone Company from 1890 to 1893.

He acted as consulting engineer of boards and commissions on many important undertakings, including the Croton Aqueduct Commission from 1884 to 1886, the Massachusetts State Board of Health from 1886 to 1904, the Metropolitan Water Board and its successor, the Metropolitan Water and Sewerage Board, from 1895 to 1909; and the Metropolitan Sewerage Commission in 1898.

Mr. Davis was one of those who were active in the revival of our Society in 1874. He became its President in 1880, and in 1908 was elected an honorary member. He was a member, director and vice-president of the American Society of Civil Engineers, and one of the writers of this memoir knows that he would have been president of that Society had he not positively declined to accept the nomination. He was also a member of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Institute of Electrical Engineers of England, and of the Century Club of New York. He was an honorary member of the New England Water Works Association.

At the time when Mr. Davis's eyesight failed to the extent that he was obliged to give up active business, he had a home in Yonkers, N. Y., and he continued to live there until his death. His sister who lived with him died after a few years, so that he had no relatives with him for nearly ten years. His trips to the city of New York became more and more infrequent. He did not become totally blind, but could read only with the help of a powerful magnifier, and went about with increasing difficulty. Notwithstanding these conditions, his mind was alert and he kept well informed as to the news of the day, and was generally bright and cheerful.

Reference has already been made to Mr. Davis's strong influence over his assistants while city engineer of Boston. Mention has often been made by these men of the influence which he has had upon their lives. His influence was not limited to them, but was felt by all those with whom he came in contact.

One who was with him during all the later years of his life makes this statement:

"One of the most beautiful tributes to Mr. Davis's influence as a man, from my point, was in the many letters that came to him from time to time from men whose names he had forgotten, but who had been under him as young men. One of these letters ran something like this: 'You have doubtless forgotten me, but I can never forget you or your influence over me and all the boys in your office. I owe you an everlasting debt, and think of you constantly. I have a good income, an attractive home, and wife and children of the best, and feel that I owe this result in large part to your influence and training.'"

The statement also says:

"Mr. Davis would hand these letters to me with such a modest air - and yet with such satisfaction - and say, 'Perhaps you would like to read this, but I do not deserve what he says.'"

One of the writers of this memoir has called on Mr. Davis nearly every year since 1905, and there appeared to be little change in his condition from year to year, but in January, 1917, it was noticed that although he seemed fairly well, he was not quite what he had been. During the winter his walks were

shorter, and unless the weather was favorable he would not go beyond the piazza. He would tire of his evening reading rather sooner than the year before, but, except for these slight changes, he was well to the day before his death.

On March 30 last, he went out for his usual walk after luncheon, and returned in good spirits. At dinner time he did not appear as usual, and upon investigation it was found that he was lying unconscious on the floor of his room. He evidently had been dressing for dinner when the stroke came, and apparently had suffered no pain. He remained unconscious until late the next day, when he passed away.

Mr. Davis was a delightful companion and had a most genial and happy disposition. His associates of many years speak of him as one whom it was a supreme pleasure to know.

Mr. Theodore Cooper says of him:

"He never relaxed either in business or in personal intercourse from the highest and noblest standards. He was always one of my best and staunchest friends, and one for whom I had the highest regard."

Mr. Charles Macdonald writes:

"I would say that Joseph P. Davis was in the very best sense the ideal type of an engineer, with a mind carefully trained to investigate nature's laws and the ability to apply those laws for the benefit of his fellow-men. He never hesitated to attack even the most complicated problems with a confidence of success which is the true inspiration for great achievement.

"In his solution of the water supply and sewerage system of Boston he was able to present such convincing facts, coupled with a rare diplomatic skill, as to effectually harmonize all conflicting interest; with the result that the greatest good has been accomplished with a minimum expenditure, which, after all, is the true test of engineering excellence.

"With such an equipment it is not to be wondered at that his advice and coöperation were eagerly sought for elsewhere, as the record indicates.

"As a man among men his guiding motive was to do that which was right, without a shadow of turning, and to promote peace and good-will among those with whom he had to do."

HAROLD PARKER.*

DIED NOVEMBER 29, 1916.

HAROLD PARKER was born in Charlestown, Mass., June 17, 1854, the son of George Alanson and Harriet Newhall Felton Parker, and was a direct descendant of Capt. Joseph Parker, who settled in Newbury in 1638, and of Nathaniel Felton, who settled in Salem in 1633.

After receiving a preliminary private school education in Philadelphia, Pa., and in Lancaster, Mass., he entered Phillips Exeter Academy, from which he graduated, and then entered Harvard College, continuing his studies there during 1871 and 1872.

Leaving college for a business career, he was first employed as foreman with the Pennsylvania Steel Company and later in the operating department of the Pennsylvania Railroad.

In 1874 he returned to his home town, Lancaster, Mass., and entered upon the practice of civil engineering, organizing in 1882 the civil engineering firm of Parker & Bateman, afterward Parker, Bateman & Chase, remaining a member of this firm until his death.

For a time he was actively engaged in railroad construction, in which work he was associated with his father, George A. Parker, who was an eminent engineer. In the early '80s they built the Charlottesville & Rapidan Railroad in Virginia, and in 1886-87 the Zanesville & Ohio River Railway in Ohio.

Notwithstanding the fact that he was of modest disposition and was not of the office-seeking type, he was prominent in the public affairs of his home town of Lancaster, and was twice elected to represent his district in the legislature. His best years in public service, however, were devoted to the work of building up the state highway system of his native state of Massachusetts. In 1900 he was appointed by the Governor as member of the Massachusetts Highway Commission, and upon the resignation of William E. McClintock in June, 1908, he was made chairman, which position he held until 1911, when he resigned to again devote his time to other than public office. His ability and tire-

* Memoir prepared by Arthur W. Dean and William E. McClintock.

less industry added to the good repute for gaining progress and results for which this commission had already become widely known. The revolution in methods of highway transportation and consequent revolution in methods of highway construction was at its height during Mr. Parker's administration as chairman, and to his thought and foresight are many indebted who are continuing the work so ably carried on by him. In 1908 he was appointed by the Governor of Massachusetts to represent the Commonwealth at the International Road Congress, held in France.

Immediately following his resignation as highway commissioner, he became vice-president of a large contracting firm, thus continuing to devote his time to road and pavement work.

In 1913 and 1914 Mr. Parker served the state of New York in an advisory capacity, being designated by Governor Dix as a member of the advisory board of the highway department.

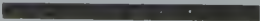
Being a lover of nature, he spent his leisure in the fields and woods, taking much interest in the forests and natural resources of his neighborhood and state, and considering as a pleasure rather than a duty his services as chairman of the Massachusetts Forestry Commission and of the Wachusett Mountain Reservation Commission.

Indication of his recognition by others in his chosen field of effort is shown by his selection as president of the Massachusetts Highway Association and of the American Road Builders' Association, in both of which societies he took great interest.

He was a man of the sturdy New England type, of high principles, and a most true friend to those who won his friendship.

Mr. Parker is survived by his widow, Elizabeth B. (Bartol) Parker, to whom he was married in 1884, and by one son and two daughters.

Mr. Parker was a member of the American Society of Civil Engineers from 1899 until his death, and was elected member of the Boston Society of Civil Engineers on March 21, 1894. His interest in this Society is shown in a material way by his gift of several valuable volumes to the library.



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ABBREVIATIONS. — D. = Discussion; I. = Illustrated.
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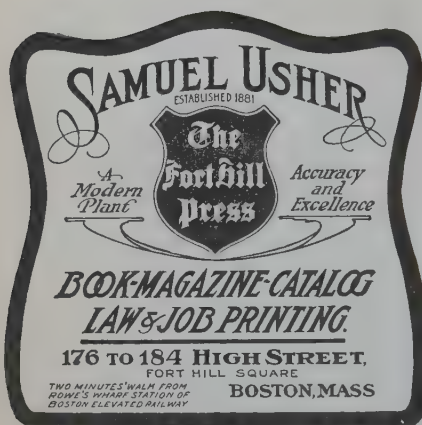
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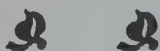
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